CLAIMS

What is claimed is:

1. A system comprising:

a symbol estimation module for determining, for a multi-dimensional symbol r_k^D having D dimensions, where D is an integer greater than 1, an estimate of the multi-dimensional symbol; and

a residual determination module coupled to the symbol estimation module for determining a residual or a function thereof for the multi-dimensional symbol responsive to the multi-dimensional symbol r_k^D and the estimate.

2. The system of claim 1 wherein the multi-dimensional symbol estimate comprises the vector s_k^D.

3. The system of claim 1 wherein the multi-dimensional symbol estimate comprises the scalar s_k.

4. The system of claim 1 wherein the residual comprises the residual vector z_k^D.

5. The system of claim 1 wherein the residual comprises the scalar z_k.

6. The system of claim 1 wherein the residual is a phase residual.

7. The system of claim 1 wherein the residual is an orthogonal component residual.

8. The system of claim 5 wherein the residual z_k is a composite residual.

9. The system of claim 1 wherein the residual determination module determines a function of the residual vector r_k^D.

10. The system of claim 9 wherein the function is the average of the individual components of the residual vector r_k^D.

11. The system of claim 1 wherein the system estimation module also determines a reliability metric R_k for the estimate of the multi-dimensional symbol, and weights the residual or function thereof using the reliability metric.

12. The system of claim 1 further comprising a phase determination module for determining a derotation phase responsive to the residual.

13. The system of claim 12 wherein the derotation phase is the vector θ_k^D.

14. The system of claim 12 wherein the derotation phase is the scalar θ_k.

15. The system of claim 1 further comprising a phase determination module for determining a phase offset estimate responsive to the residual.

16. The system of claim 15 wherein the phase offset estimate is the vector $\Delta\theta_k^D$.

17. The system of claim 15 wherein the phase offset estimate is the scalar $\Delta\theta_k$.

18. The system of claim 12 further comprising a symbol derotator for derotating each of the individual symbols in the vector r_k^D responsive to the derotation phase.

19. The system of claim 15 further comprising an accumulator for determining a derotation phase responsive to the phase offset estimate.

20. The system of claim 19 further comprising a symbol derotator for derotating each of the individual symbols in the vector r_k^D responsive to the derotation phase.

21. The system of claim 1 wherein the symbol estimation module comprises a decoder capable of producing soft estimates.

22. The system of claim 21 wherein the decoder is a log-MAP decoder.

23. The system of claim 12 wherein the phase determination module updates the derotation phase at the frequency of individual symbols in the multi-dimensional symbol.

24. The system of claim 15 wherein the phase determination module updates the derotation phase once for each multi-dimensional symbol.

25. The system of claims 12 or 15 in a carrier tracking module.

26. The carrier tracking module of claim 25 in a receiver.

27. The receiver of claim 26 in a communications device.

28. A set-top box which comprises the communications device of claim 27.

29. A system comprising:

a symbol estimation module for determining, for a multi-dimensional symbol r_k^D having D dimensions, where D is an integer greater than 1, an estimate of the multi-dimensional symbol;

a residual determination module coupled to the symbol estimation module for determining a residual or a function thereof for the multi-dimensional symbol responsive to the multi-dimensional symbol r_k^D and the estimate; and

a phase determination module for determining a derotation phase or phase offset estimate for the multi-dimensional symbol responsive to the residual or function thereof.

30. The system of claim 29 further comprising a symbol derotator for derotating each of the individual symbols in the multi-dimensional symbol r_k^D responsive to the derotation phase.

31. The system of claim 29 further comprising an accumulator for determining a derotation phase for the multi-dimensional symbol responsive to the phase offset estimate.

32. The system of claim 31 further comprising a symbol derotator for derotating each of the individual symbols in the multi-dimensional symbol responsive to the derotation phase.

33. A system comprising:

symbol estimation means for determining, for a multi-dimensional symbol r_k^D having D dimensions, where D is an integer greater than 1, an estimate of the multi-dimensional symbol;

residual determination means coupled to the symbol estimation means for determining a residual or a function thereof for the multi-dimensional symbol responsive to the multi-dimensional symbol r_k^D and the estimate.

34. A method comprising the steps of:

determining, for a multi-dimensional symbol, an estimate of the symbol; and

determining, responsive to the estimate, a residual or a function thereof.

35. The method of claim 34 wherein the multi-dimensional symbol estimate comprises the vector s_k^D.

36. The method of claim 34 wherein the multi-dimensional symbol estimate comprises the scalar s_k.

37. The method of claim 34 wherein the residual comprises the residual vector z_k^D.

38. The method of claim 34 wherein the residual comprises the scalar z_k.

39. The method of claim 34 wherein the residual is a phase residual.

40. The method of claim 34 wherein the residual is an orthogonal component residual.

41. The method of claim 38 wherein the residual z_k is a composite residual.

42. The method of claim 34 further comprising determining a function of the residual vector r_k^D.

43. The method of claim 34 further comprising determining the average of the individual components of the residual vector r_k^D.

44. The method of claim 34 further comprising determining a reliability metric R_k for the estimate of the multi-dimensional symbol, and weighting the residual or function thereof using the reliability metric.

45. The method of claim 34 further comprising determining a derotation phase responsive to the residual.

46. The method of claim 45 wherein the derotation phase is the vector θ_k^D.

47. The method of claim 45 wherein the derotation phase is the scalar θ_k.

48. The method of claim 34 further comprising determining a phase offset estimate responsive to the residual.

49. The method of claim 48 wherein the phase offset estimate is the vector $\Delta\theta_k^D$.

50. The method of claim 48 wherein the phase offset estimate is the scalar $\Delta\theta_k$.

51. The method of claim 45 further comprising derotating each of the individual symbols in the vector r_k^D responsive to the derotation phase.

52. The method of claim 48 further comprising determining a derotation phase responsive to the phase offset estimate.

53. The method of claim 52 further comprising derotating each of the individual symbols in the vector r_k^D responsive to the derotation phase.

54. The method of claim 45 further comprising updating the derotation phase at the frequency of individual symbols in the multi-dimensional symbol.

55. The method of claim 45 further comprising updating the derotation phase once for each multi-dimensional symbol.

56. A computer readable medium tangibly embodying any of the methods of claims 34-55.

57. The computer readable medium of claim 56 which comprises a memory.

58. Circuitry which tangibly embodies any of the methods of claims 34-55.